INNOVATION

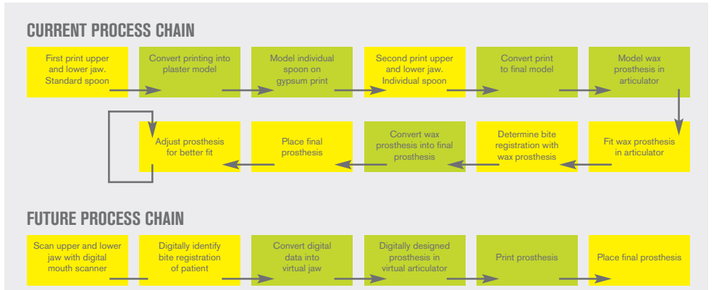
FIELDLAB MULTIM3D WORKS ON HIGHLY PROMISING SOLUTION FOR BILLION EURO MARKET

CREDIBLE DENTURES THANKS TO 3D-PRINTING

An older person smiles and a straight row of snow-white teeth appears. Not real, you know immediately. Not only because it is unlikely that someone of that age still has such beautiful teeth, but even more because it is too uniform and too white. It is very difficult to imitate teeth properly. 3D printing technology can change that. Within the Smart Industry fieldlab Multi-material 3D printing (MultiM3D), TNO, Océ Technologies and NextDent are working hard to find a solution for which there may be a billion-euro market lying in wait.

BY MARTIN VAN ZAALEN

'It is very difficult to recreate the colour and structure of real teeth. That is why you very quickly see whether someone is wearing dentures or has false teeth,' says René van der Meer, lead technologist for industrial printing at Océ's R&D department in Venlo. He researches technologies for digital printing of everything, except paper. And now he is fully committed to a technology for 3D printing of teeth, within MultiM3D. That fieldlab—one of 32 in the Smart Industry initiative of FME, VNO-NCW, the Ministry of Economic Affairs and Climate Policy, Stimulus and TNO—has three work packages. One focuses on 3D printing of ceramic materials, a second on printed electronics (see box). The third one, in which Océ is active, therefore involves 3D printing of teeth. Océ, a division of Canon, does this together with specialists from TNO AMSYSTEMS Center *(Additive Manufacturing Systems Center)*, Next-Dent and TNO BMC (Brightland Materials Center). Each party is responsible for its own package. Project partner NextDent from Soesterberg (supplier of dental products for eighty years and part of the American 3D Systems since the beginning of 2017) provides an FDA-approved mono-colour material that is 3D-printable on the basis of VAT-photopolymerisation (cured with UV-light). TNO BMC, located on the Brightlands Chemelot Campus, modifies this dental resin to make it printable and suitable for colouring teeth and acquiring the mechanical properties of teeth. TNO AMSYSTEMS Center focuses on the integration of the VAT and inkjet technologies into a complete 3D printer. In addition, Van Mierlo Ingenieursbureau (specialist in the realisation of hardware and software solutions for measurement and control problems), as Océ's partner, develops the required control electronics of the printheads.



This figure compares the current and desired process flow for the manufacture of prostheses. 3D printing has the advantages of less manual work, fewer errors (which are caused by the many conversions in the current process), simple reproduction and a shorter turnaround time. The yellow steps take place at the dentist, the green at the dental laboratory. Source: Fieldlab Multi-material 3D Printing Project Plan (2016).

THE OTHER TWO WORKSHOPS OF MULTIM3D

The Fieldlab MultiM3D is a co-creation platform of industrial parties from the entire value chain and knowledge organisations. Three multi-material use cases have been defined based on business questions. In addition to the research on dental applications, we are working on:

1 Large-area ceramic printing for high-tech applications. This offers opportunities for producing large surface machine parts in a significantly shorter time and at significantly lower costs. The challenge lies in the integrated development of the combination of material, process and equipment.
2 Integrated electronics opens up new possibilities in product design and functionality of (consumer) electronics products, such as LED lighting with integrated electrical functions. The challenge lies in the integration and combination of multiple AM techniques and methods, including for the manufacture of mechanical and optical structures and the application of 3D electrical structures and components.

Partners in this fieldlab are: TNO BMC, TNO AMSYSTEMS Center, High Tech Systems Center (TU Eindhoven), ECN, Admatec, NextDent, Océ, Philips Lighting, DoMicro, PwC, ASML, XYCarb, BOM and LIOF. The fieldlab is located in Eindhoven.

www.smartindustry.nl/7-multimateriaal-3d-printen

INKJET TECHNOLOGY

'And we give the teeth colour and structure,' is how Van der Meer defines the contribution of Océ. To this end, Océ supplies the digital inkjet printhead, technology that the company obviously understands. The technology developed by the company for so-called 2.5D printing, a form of 3D printing up to a height of about 5 millimetres, also comes in handy. This means, for example, that exact copies of old Dutch masters including the paint structure can be printed. In addition, the Venlo company has advanced (2D) colour management software. Océ also studies 3D workflow software. The 3D structure of a tooth is made up of—what is called in the sector—voxels: 3D pixels of, for example, 40 by 40 by 40 micrometres. If they are all of the same size and colour for 2.5D printing, for printing teeth that are not distinguishable from real teeth, each voxel must have its own characteristics—colour and transparency. 'This is possible thanks to our 3D Full Colour Workflow software, which accurately translates the digital design of the tooth into data for control of the printhead. With our printhead and control software and the VAT printer from TNO AMSYSTEMS, we are able to print every voxel in exactly the right colour and transparency in exactly the right place. And do it rapidly. A complete tooth can be printed within half an hour.' In the fieldlab, digital piezo inkjet printheads specially developed for highly viscous materials and high temperature are used for this 3D printing (Océ also applies these in wide-format colour printers such as the ColorWave 600). For future products Océ is currently developing MEMS (micro-electro-mechanical systems), printheads that are made in chip factories. This new generation of printheads is not only more compact and cheaper, but also much faster and more accurate.

BILLION EURO MARKET

Océ and its fieldlab partners are making this effort because they foresee a large market. Expectations are that in ten years' time artificial teeth will be exclusively 3D-printed, good for global revenues of ten billion euros, says Van der Meer citing a market survey of Smart Tech Publishing (2018). The Fieldlab Multi-material 3D Printing Project Plan (2016) reports that approximately four million dental prostheses are produced annually in the Netherlands alone. The number of crowns and bridges is a multiple of this. The consumer price for a crown (un-placed) in the Netherlands is currently around 230 euros, for a partial prosthesis this is about 160 euros.

> 'Expectations are that artificial teeth will be exclusively 3D printed in ten years'

The total turnover of Dutch dental laboratories for these two types of dental work is therefore hundreds of millions. If it is possible to print aesthetically acceptable multi-colour teeth for dental prostheses and crown and bridge work, twenty per cent of the dental items can be made in the Netherlands within four years. The revenue model of NextDent will initially consist of selling materials for these products. In addition, there is a market for an equipment supplier that supplies and maintains printers. For Océ, the results offer opportunities to acquire a position outside the company's traditional 2D printing markets. 'And we see even more biomedical applications for this technology, like printing skin, noses, eyes and ears,' says the Océ man.

Using 3D printing technology to imitate the structure and colour of a real tooth as closely as possible is difficult. This is how Océ man René van der Meer outlines the challenge of the MultiM3D fieldlab. Photo: Com-magz

COOPERATION PROCEEDING WELL

The collaboration in the fieldlab between the four partners is progressing well, says Van der Meer. 'We meet regularly or have telco's to discuss problems and to agree who can do what to adjust the parameters in order to achieve better results. So far, we have been working purely with the development of materials, hardware and software. But soon we will do the first printing on the TNO VAT-printer in Geleen, as soon as the control electronics are ready for it.' Incidentally, it is important that there are concrete results by mid-2019, because until then there is co-financing from ERDF and OPZuid.

www.oce.com
www.tno.nl
www.nextdent.com

IMPLEMENTATION AGENDA: ACCELERATE DIGITALISATION

Smart industry is changing the industry radically, but leading the way in this digitisation is crucial. That is why the Smart Industry Team set up the Implementation Agenda 2018–2021 during the Smart Industry Event at the beginning of February. Chairman Ineke Dezentjé Hamming-Bluemink presented it to Mona Keijzer, Secretary of State for Economic Affairs and Climate Policy. The agenda wants to speed up the digitisation of companies, so that in 2021 the Netherlands has the most flexible, digitally connected and competitive production network in Europe. There are nine projects:

1 Smart Industry Assessment Programme. Helping companies to get started with Smart Industry.
2 Smart Industry Expertise Centre. One-stop shop for companies.
3 Smart Industry Hubs. Setting up a network of regional Smart Industry Hubs.
4 National Roadmap Smart Industry. Description of the intended development of Smart Industry knowledge.
5 Linking skills labs to fieldlabs. Making every fieldlab also a skills lab.
6 Human-oriented Technology Programme. Developing best practices.
7 Cyber Security Programme. Making manufacturing companies digitally resilient through the arrival of a Smart Industry Digital Trust Centre.
8 Data Sharing Programme. Establishing the Data Value Centre and the Data Share Coalition.
9 International business with Smart Industry. Setting up concrete cooperation projects in the Netherlands, Germany and Belgium.

www.smartindustry.nl